Field Attractiveness of the Synthetic Sex Pheromones of the Rice Stem Borer Moth, Chilo suppressalis Walker (Lepidoptera: Pyralidae)

AUTHOR(S):

TATSUKI, Sadahiro; OHTA, Kyuji; UCHIUMI, Kyoichi; KURIHARA, Masaaki; FUKAMI, Jun-ichi; KISHINO. Ken-ichi

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Field Attractiveness of the Synthetic Sex Pheromones of the Rice Stem Borer Moth, *Chilo suppressalis* Walker (Lepidoptera : Pyralidae). Sadahiro TATSUKI, Kyuji OHTA*, Kyoichi UCHIUMI, Masaaki KURIHARA, Jun-ichi FUKAMI (The Institute of Physical and Chemical Research, Wako-shi, Saitama 351 Japan) and Ken-ichi KISHINO (Tohoku National Agricultural Experiment Station, Omagari, Akita 014-01 Japan). Received July 16, 1976. *Botyu-Kagaku*, 42, 1, 1977.

1. ニカメイガの合成性フェロモンの野外における誘引性 田付貞洋，太田九二，内海恭一，栗原政明，深見順一（理化学研究所，埼玉県和光市），岸野賢一（農林省東北農業試験場） 51. 7. 16 受理

ニカメイガの合成性フェロモン，シス-11-ヘキサデセナールとシス-13-オクタデセナールの野外でのオスに対する誘引性を調べたところ，両者を一定の割合で混合した場合にのみ誘引性がみられた．すなわち，1μgの混合物では，シス-11-ヘキサデセナールとシス-13-オクタデセナールの混合比が1：1～20：1に活性がみられたのに対し，1：3の混合物および，それぞれ単独の化合物には誘引がみられなかった．

The rice stem borer, *Chilo suppressalis* W., is one of the most important insect pests of rice culture in the temperate-subtropical regeon of Asia.

The presence of a sex pheromone in this species was first suggested by the early investigation of Kaburaki *et al.*[1] using McIndoo's olfactometer. It has since been reported that the sex pheromone acts as both an attractant and a stimulant, the latter initiates the mating dance prior to copulation[2]. Isolation and characterization studies were undertaken, however, attempts to identify the chemical structures were unsuccessful due to limited materials[3].

Recently, Nesbitt *et al.*[4] reported that the sex pheromone of this moths collected in the Philippines is a mixture of (*Z*)-11-hexadecenal and (*Z*)-13-octadecenal. These researchers relied heavily on electroantennogram (EAG) assays and gas chromatographic (GLC) retention data to reach their decision. They also referred to the field attractiveness of the synthetic pheromone mixture, but detailed data were not presented. Independently, we identified the pheromone structures, by using GLC, GLC-mass spectrometry and EAG, as the same two compounds reported by the English investigators[5]. The activity of synthetic mixtures was studied using 25% to 95% (*Z*)-11-hexadecenal (HDAL) in (*Z*)-13-octadecenal (ODAL). A peak of activity occurred at the 75% mixture as monitored by a laboratory bioassay utilizing the mating dance as the sensing agent. However, attractiveness of the 75% (3:1) mixture could not be demonstrated by attraction tests in a laboratory flight chamber. Therefore, a field test was designed to confirm the attractiveness of the synthetic pheromones to male *C. suppressalis*.

Synthetic pheromones used for this study were the same as in the previous report[5]. The purity was greater than 98% as determined by GLC.

One- or two-day-old virgin females were obtained from a rearing program utilizing rice seedlings as the larval diet at the Institute of Physical and Chemical Research[6]. Female pupae and emerged adults were held in a wire screen cage (23×23×32cm) at the room temperature under a natural photoperiod.

Field tests were conducted in a paddy field of the Tohoku National Agricultural Experiment Station, Omagari, Akita Prefecture in June, 1976. The sticky traps, Pherocon® 1C (Zoecon Corp., U.S.A.**), were placed at 15-20m intervals in two parallel straight lines which were about 200m apart at a height of 30-40cm. A hexane solution of the chemicals was placed on a piece

* Present Address : Niigata Engineering Co. Ltd., Kamatahoncho, Ota-ku, Tokyo.
** They were kindly supplied by Dr. Siddall of Zoecon Corp.

of filter paper that was hung in the middle of a trap and secured with adhesive tape. Two virgin females were confined in a plastic vial (6×3cm) with wire screen ends. The vial was placed directly on the sticky surface of a trap. The traps were baited within about 30min of 19:45hr to 20:40hr during which time the male is in flight searching for females[7]. The number of males captured in traps were counted about 2hr after the baiting.

Preliminary field tests showed that each mixture of HDAL and ODAL in ratios of 3:1 (optimum ratio for the activity obtained from laboratory bioassay[5]), 5:1 (active mixture reported by Nesbitt *et al.*[4]) and 7:1 (naturally occurring ratio in our previous study[6]) was attractive to males at the total level of 1 or 10μg. Thus, six mixtures in ratios of 20:1, 7:1, 5:1, 3:1, 1:1 and 1:3 using 1μg of mixture per trap were tested simultaneously along with the individual compounds at the 1μg level and two virgin females. The data obtained from six successive nights are summalized in Table 1. It is clearly shown that synthetic HDAL and ODAL were attractive when they were mixed together in ratios of 1:1 to 20:1. On the contrary, 1:3 mixture and each individual compound alone were shown to be quite inactive. Among the active mixtures, 3:1, 5:1 and 7:1 mixtures were equally more attractive than the 1:1 and 20:1. These data confirm the result of Nesbitt *et al.*[4] and almost coincide with the result of our laboratory bioassay[5]. Moreover, the attractiveness shown by pheromone mixtures of a relatively wide range of ratios is similar to of *Heliothis virescens* (F.) whose sex pheromone is a mixture of (*Z*)-11-hexadecenal (same as the major component of the *Chilo* sex pheromones) and (*Z*)-9-tetradecenal[8,9].

Table 1. Numbers of Native Male *Chilo suppressalis* Captured in Field Traps Baited with Synthetic Pheromones and Virgin Females.

Bait	Total No. males captured[a]
HDAL[b] (1μg)	1
ODAL[b] (1μg)	0
HDAL+ODAL (total 1μg)	
20:1	11
7:1	27
5:1	30
3:1	29
1:1	13
1:3	0
Virgin females (2)	66
Hexane control	0

a) Two traps/test; June 6-11, 1976; Omagari.
b) HDAL: (*Z*)-11-hexadecenal, ODAL: (*Z*)-13-octadecenal.

In these field tests, all the 1μg mixtures were less attractive than two live females. It is believed that this level of activity is a result of method in which these chemicals were dispensed, although some other factors related to the attractiveness remain to be evaluated.

The effective period of the active mixtures at 1μg level treated on filter papers was about 2hr. This was probably due to rapid evaporation or/and degradation of the compounds. To prolong the effectiveness of the compounds for a longer period in field investigations, use of pheromone dispensers such as rubber septa, polyethylene wicks, etc. should be examined. Furthermore, considering that many aldehydes are readily oxidized by atmospheric oxygen molecules, an appropriate antioxidant mixed with the pheromones would probably prolong activity.

The lack of attractiveness of the synthetic mixture in the laboratory can not be fully interpreted, however, a time lag between the sexually active time of the males released and the effective period of the chemicals baited might be a factor.

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Studies on the Toxic Action of Insecticides against Insects. III. Quantitative Expression of Toxicities of Several Insecticides against Larvae of the Silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae) and of the Fall Webworm, *Hyphantria cunea* Drury (Lepidoptera: Arctiidae). Kimihiko SATO and Masana SUWANAI (Faculty of Agriculture, Tokyo University of Agriculture and Technology, Fuchu, Tokyo, Japan) Received July 22, 1976. *Botyu-Kagaku*, 42, 3, 1977. (with English Summary 9)

2. 殺虫剤の昆虫に対する致死作用に関する研究（第3報）数種殺虫剤のカイコガ幼虫およびアメリカシロヒトリ幼虫に対する殺虫効力の定量的表現法

佐藤仁彦，諏訪内正名（東京農工大学農学部，東京都府中市幸町3-5） 51. 7. 22 受理

令の異なるカイコガ幼虫およびアメリカシロヒトリ幼虫に対する5種類の殺虫剤（DDVP，マラソン，パラチオン，γ-BHC および NAC）の施用薬量と致死時間の関係を調べた．体重が一定の虫の個体群については，限界致死施用薬量を W_0，限界致死時間を T_0 とすれば，施用薬量Wと致死時間Tとの関係は $(W-W_0)(T-T_0)=K$ で表わされる．Kは定数である．Kと虫体重Mとの関係は $K=aM+B$ となる．a および B の値は供試虫と殺虫剤の組合せにより決まる定数であり，これらの定数の大小により当該昆虫に対する供試された範囲内の殺虫剤の効力を推定できることが判かった．

令の異なるカイコガ幼虫に対する殺虫剤の効力について，砒酸の比毒効速度についての Campbell[1]，ピレトリンの LC_{50} 値についての吉田[2] および DDT・スミチオンの LD_{50} 値についての渡部・高野[3] の報告があり，それらはいずれも幼虫の令が進むにつれて各薬剤の効力が順次減少するとしているが，体重との関係を定量的に表わしている報告はない．一方，アメリカシロヒトリ幼虫に対する殺虫剤の効力については，石井[4] が BHC，ホリドール（パラチオン）などについて調べ，令が進むと殺虫効力が減少すると報告している．

殺虫剤による昆虫の致死薬量については，諏訪内[5,6] および Suwanai[7] が先きにアズキゾウムシ成虫を対象に数種殺虫剤の施用薬量—致死時間の関係を表わす実験式として

$$(W-W_0)(T-T_0)=K \qquad (1)$$

を提示した．ここに，W：施用薬量，W_0：限界致死施用薬量，T：致死時間，T_0：限界致死時間，Kは定数である．

第1報[8] では令の異なるヨトウガ幼虫に対する数種殺虫剤の効力を，第2報[9] では令の異なるハスモンヨトウ幼虫およびハチミツガ幼虫に対する数種殺虫剤の効力を調べ，施用薬量と致死時間との関係は，いずれの場合にも(1)式で表わされ，Kは定数となり，しかも，Kの値が虫の体重（M）と一次の関係

$$K=aM+B \qquad (2)$$

で表わし得ることを報告した．

本報告では，普通飼育のカイコガ幼虫およびアメリカシロヒトリ幼虫に DDVP，マラソン，パラチオン，γ-BHC および NAC をそれぞれ施用した場合，上記と同様のことが成り立つかどうかを確かめるために行なった結果を取りまとめたものである．

本文に入るに先立ち，本学大学院生広岡芳年君には供試虫の飼育等援助を受けた，ここに謝意を表す．

材　　料

供試昆虫：カイコガ幼虫一万×代系統を1976年5月11日に掃き立て，普通飼育によって生育させたもので，体重40mg（3令初期）～1,100 mg（5令初期）の範囲の幼虫をそれぞれの実験目的の体重に到達した時点において均一な体重個体を選び出して供試した．

アメリカシロヒトリ幼虫—同年6月17日，東京都府中市本学桑園内で採集した夏世代群（1令幼虫）を室温（24～26°C）で桑葉を与えて飼育したもので，体重20mg（3令初期）～160mg（5令初期）の範囲の幼虫をそれぞれの実験目的の体重に到達した時点において均一な体重個体を選び出して供試した．

供試薬剤：既報[8] と同じ DDVP，マラソン，パラ